Roy Szweda

All too soon it is time once again to take stock of the past year. While it was one some would prefer to forget overall the industry was in better shape. Time will tell as to how this accumulated momentum can be sustained. This is but one of the many questions arising in this overview of recent history and forthcoming attractions. 2004 may one day be remembered as a watershed year; the year of market shifts and repositioning of players getting themselves ready for the potential rewards and pitfalls to come. In this revisit to some of the landmarks, is added new commentary from some earlier respondents.

2004: in better fortunes

It would be nice to think that for every disappointment of the year there was a positive experience. For instance while fibre-based datacoms continue to struggle as an opto device market, data storage and general lighting have been soaring.

Simon Rushworth of Epichem is a well-travelled observer of the industry and even he cannot be sure. "It is tricky to predict what 2005 is going to be like for III-Vs. At the moment you could sum it up by saying it will be 'more of the same'. Some sectors like HB-LEDs are relatively buoyant with good growth predicted and indeed it is this area that has been the main III-Vs market in 2004". Nevertheless, prospects continue to be bright as LED applications are rolled out and the Holy Grail of a challenge to conventional lighting is still being given a lot of attention. This is even though it is still crying out for the elusive breakthrough to really explode into life. Simon is not alone in expecting this to be a matter of years not decades.

Others concur that the telecoms market remains flat: "The question being asked since its collapse is still unanswered in that no one appears to know when it will come back or even if it will ever regain its former levels."

Stable for some

Similarly, Aixtron has seen interesting market changes: "Despite the uncertain market environment in which we entered 2004, the year has proved to be highly successful for us," says Dr. Bernd Schulte, executive VP of Aixtron. "After a very volatile year in 2003, we have seen much more stable and robust growth in 2004, with a noticeable improvement in customer investment confidence". The Aachen-based company says it is now looking forward to that confidence continuing through into 2005. "And a continuation of the recent advances we have seen in both applications and process development."

DVD dominance

One thing for certain is that today's laser market is dominated by data storage applications - CD has been supplanted by DVD. However, all new systems (whether for computers or home entertainment) have to be retro-compatible. Thus the demand for AlGaAs CD lasers remains high.

Optoelectronics is well-known as an industry which continues to re-invent itself. As one wave fades another is already on the way up to take its place. DVD might be said to be peaking but is already being invigorated by recordable formats including the latest dual-layer writers. Just around the corner there is in prospect the Blu-Ray HDTV home VCR or data archival system.

Collaborations are seen as the best route for development of these very technology intensive - and therefore expensive - systems. Amongst the first were Pioneer and Rohm who partnered to develop GaN-based violet lasers for next generation optical data storage. Rohm had been the first to mass produce DVD diode lasers by MBE and probably still has the world's largest production line for these lasers.

Another partnership was in the news recently; Nichia and Sony have co-developed a wholly integrated, dual wavelength laser coupler compatible with red and blue-violet lasers but mass production is at least a year off. This could prove to be one of the biggest milestones in the commercialisation of III-N lasers since their inception by Prof Nakamura. Racing ahead is Sharp which in November introduced a new HDTV Blu-ray Disc Recorder combining hard-drive with Blu-Ray DVD. The new BD-HD100 has a 160 Gbyte drive to record 19h of HDTV -the user can archive material via the BR-DVD. Sharp says it can dub five DVDs (4.7 Gb each) onto a single Blu-Ray disc (25 Gb). However, it is unclear how much the blank discs will cost and when this machine will reach the international market. Also to look forward to may be Blu-Ray based camcorders using special 8 cm disks from Sony, Pioneer et al.

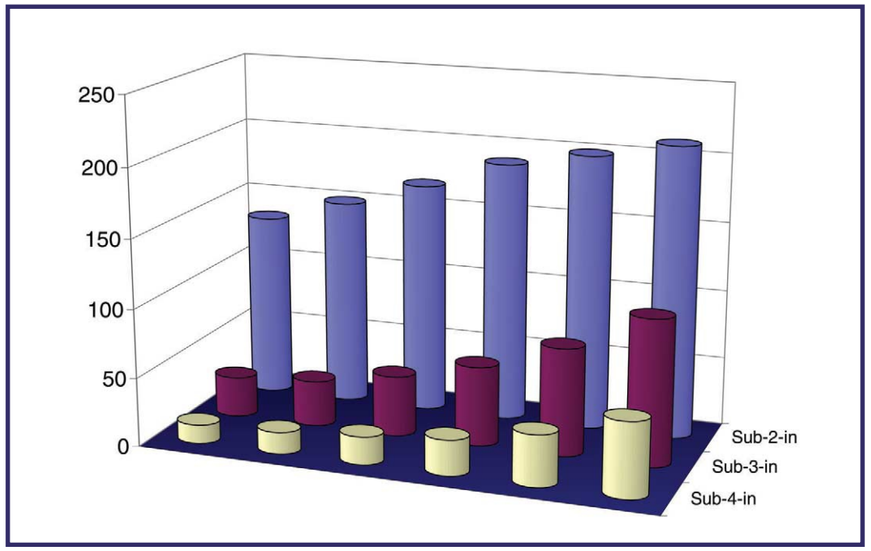

Figure 1. The evolution of the semiconductor optoelectronic substrate market shows the steady decline of the current industry standard 2-inch in favour of 3-inch and 4-inch. Over the next five years it is problematic as to which of the larger wafers will become the new standard. Much will depend on component demand, epitaxy and process economics.

Meanwhile, out of the publicity spotlight the violet laser diode has achieved much success in the instrumentation field. For example, quite a few analytical equipment OEMs are launching systems to take advantage of the special characteristics of these devices. Time-resolved stored-ion spectroscopy, atomic spectroscopy and metal ion determination are just a few of the characterisation techniques exploiting violet lasers. Other areas of interest include direct to plate printing and mastering of CDs and DVDs.

So too as the laser market evolves and shifts up the spectrum, the supporting industry has seen shifts. One of the most notable has been the ongoing rise of P-based devices for visible lasers (and in microelectronics HBTs).

This wave has been responsible for the shift in demand from MBE to MOCVD. Violet lasers also seem to be the preserve of MOCVD too so the Japanese laser experts (and others) are having to learn a new discipline though it is claimed this is not a major new learning curve. Behind the scenes there must be some very interesting technology underway. Patents confirm the progress in multi-wavelength optical pick ups including multiple lasers, detectors and other devices.

Continuing the opto theme, Toby Strite, Business Development manager at JDS Uniphase Components Products Group says that two things happened last year and will continue into 2005.

First of all it concerns that sadly over-used word 'consolidation'. The company is well-known for its dynamic acquisition strategy and as a result has to inwardly digest them. "JDSU has spent most of its resources in 2004 completing the closure of our Philips (source lasers) and Epitaxx (detectors) fabs to consolidate all semiconductor processing into the former SDL facility in California. Fabs are expensive and JDSU has decided it can only afford one mega fab. If you look at companies like Bookham and Avanex, they've gone down the same path or will soon. Even though our market is picking back up, at these volumes and prices, JDSU had to further lower its cost to hope to make a profit".

The second topic which he has found interesting over the past year has been 'pluggables': "Fibre-pigtailed source lasers and receivers are giving way to receptacled solutions in higher and higher end applications. While the 300-pin transponder is safe in long haul and high channel count DWDM, most every other application will go SFP or XFP or something else along those lines. What this means to the III-Vs people is added focus on chip engineering to meet the demands of TOSA/ROSA platforms which go into the plug-

gable transceiver marketplace. Performance must be maintained, while size/power consumption must fall markedly. JDSU is investing in III-V alloy mixtures which better enable high temperature Tx and Rx operation to minimize the amount of TEC cooling needed."

Just recently TFR spoke to various players in the re-emergent VCSEL market. Karl Heinz Gulden of Avalon Photonics reported that Avalon has flourished but others have not fared so well. He sees good news as well as bad for VCSELs: "Even though the consolidation process over the last three years has reduced the number of VCSEL companies from about 30 to less than 12. This process is likely not finished," he says. "Overall there will be a stronger focus on applications outside of datacom: up to now the datacom market has been by far the most important market for VCSELs. This market is still growing with speed requirements increasing to 4.25 Gbps. However, the strong price erosion and ongoing industry consolidation limit the attractiveness of this market. Emerging new markets for 850 nm devices, such as optical navigation or encoder applications will become important beginning next year. This provides new opportunities for component manufacturers who are able to fabricate dedicated devices for these applications".

SiGe & RFCMOS

Earlier in the year we spoke to two of the market leaders in the SiGe IC field, IBM Microelectronics and Jazz Semiconductor. Here's what they had to say by way of an update on this fast moving industry sector.

Paul Kempf, Chief Marketing and Technical Officer at Jazz Semiconductor has noted that one of the biggest developments in the high performance analog market segment over the last year has been the trend toward analog/RF integration: "New product developments using specialty silicon, like high output power amplifiers integrated with WLAN RF transceivers, or LDO regulators with direct conversion radios, have demonstrated a new path for analog/RF subsystem integration."

Teddy O'Connell, Business Development manager for Foundry Technologies at IBM indicates that the market is still strong in newly emerging applications, such as GSM EDGE cell phones, 3G cell phones, MIMO (Multiple Input, Multiple Output) WLAN, and multi-application devices that require multiple RF transceivers. In general as the market moves towards these new applications, which are "performance driven" then SiGe will continue to be required.

Also, companies such as IBM now offer multiple versions of SiGe technologies, so that customers have the choice of using high-end, high performance processes for demanding applications or lower performance SiGe processes that can handle the less demanding applications such as: 802.11g WLAN, Bluetooth, etc. "Looking ahead to 2005, we still expect the market to be strong both for SiGe technologies and also RF CMOS.

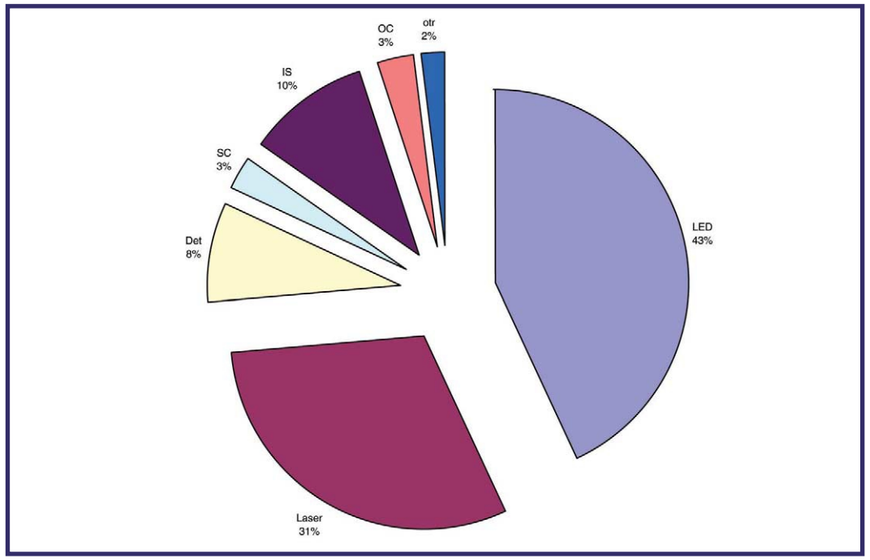

Figure 2. Market shares for principal semiconductor optoelectronic components (Det - detector, SC - solar cell, IS - image sensor, OC - optocoupler, and other). The continuing dominance of the emitters and especially LEDs is clear. Thanks to general illumination for static and vehicular applications high brightness LEDs will make up half of this market by the end of the decade.

Figures are taken from the forthcoming new third edition of the 'Strategic Study of the Worldwide Semiconductor Optoelectronic Components Industry to 2008' *from Reed Electronics Research, Wantage, Oxon, UK Contact: anita.caird@rer.co.uk*

What continues to be important to customers is that they have good quality RF models and Design kits to that new designs exhibit good quality model to hardware correlation, and the time to market is minimized."

Long-term GaAs

Asif Anwar of Strategy Analytics sees the III-V market continuing to be dominated by GaAs, with InP and GaN remaining in the wings in 2005. "The cellular market will remain key for growth in the GaAs device industry, but it is no longer sufficient to have good HBT/HEMT capability to be successful in this marketplace.

"Overall, it is becoming more expensive to participate in the RF product business. In 2005, those involved in the cellular market will face the additional challenge of a downward trend in cellular handset shipment growth. Strategy Analytics believes handset sales will peak in 2004 at 670m, representing 30% year-on-year growth with expansion in 2005 slowing down to 8%. Despite these challenges, we expect GaAs and III-V technologies in general to continue as technology enablers in a vast array of end markets from cellular to fibre optics to millimetre-wave."

Marc Rocchi, CEO of OMMIC, has some other thoughts to share about the industry. He is convinced that III-V MMICs will only continue to grow when they do offer real performance added value with respect to SiGe or RF CMOS solutions in the eyes of system designers.

"This commonplace statement implies that the use of III-V technologies will always be limited to those applications with a roadmap where linearity, NF, P1dB, gain, efficiency all do matter at the same time and where these specifications have to be constantly improved for all new system generation. As an example, the cellular roadmap is consistent with the long term requirements for III-V PAs and switches for handsets or base stations.

"Conversely, I do not believe in the long term use of III-V MMICs in car radars since the specifications are frozen and not tough enough. This implies that SiGe should easily catch up. III-V MMICs can only develop by constantly staying ahead of any silicon solutions, as long the dynamics of the applications asks for it."

The consequence is, he says, that III-V MMICs will remain a technology for niche applications and most of the time for the high tier part of the applications. "It also means that a silicon-like type of scaling down is highly required even if the frequency of operation isn't changing while the specifications to be met actually are. In this context, OMMIC is continuing to focus on processes and services with a clear differentiator. We call this the FAB+ service. It includes sub-0.2 µm E/D PHEMT, embedded MEMS, known good bumped dies, high sensitivity TIAs, high linearity LNAs, highly integrated core chips for phased array antennas."

In summary

This article has posed as many questions as it has attempted to answer. That is inevitable. It is a reflection of the uncertainty to be found in the semiconductor industry. The replies are varied and to some extent contradictory. When asked a question as to whether the better days returned to the industry in 2004, nearly everyone would respond with a qualified yes. The good fortune was as ever unevenly spread. Prospects are certainly rosier than they might have been at the start of the year but the need for more cautious optimism keeps appearing in the media. As someone once said, you can talk yourself into a depression. Equally the industry can talk itself into success.

A certainty has been the success of DVD and the delayed resurgence of telecom. Speculation will perhaps continue as to the timing of firm recovery in fibre networks. The worry is that other technologies, e.g. free space optics, are coming along. Conversely, over the longer term observers are suggesting that with better data compression combined with fibre 'on-demand' delivery there may be no need for anyone to maintain a data archive. Blu-Ray may turn out to have been a dead-end.

Somewhat troubling is an alternative scenario where fibre loses out to enhanced DSL. A so-called '3-in-1' service is coming: Internet, IP telephony (VoIP) and video-on-demand, all via existing phone lines. It will give the cable and DBS service providers a tougher time. But if we do genuinely desire high-definition video on-demand then fibre delivery is likely going to be inevitable.

When - or if - this happens is another big question which will no doubt tax the industry's finest business brains until next year's annual overview (and beyond).